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ANALYSIS OF THE NAVY'S TIMEKEEPING SYSTEM
VERSUS AUTOMATED ALTERNATIVES

by

Cindra E. Otto

December 1985

Thesis Advisor: Shu S. Liao

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The Department of the Navy is presently operating under a predominately manual system for the collection of attendance and labor distribution data. Recent technological progress in automated data collection systems has provided a multitude of alternative means of collecting this source data.

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Analysis of the Navy's Timekeeping System Versus Automated Alternatives

by

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Lieutenant, United States Navy
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I. INTRODUCTION

A. BACKGROUND

The Navy's current payroll systems were originally designed for first and second generation data processing hardware at a time when the civilian payroll environment was far less complex than today. Current legislative, regulatory and statutory requirements have exceeded the system's capabilities for efficient pay reporting and processing.

The Navy is presently operating combinations of standard/unique/manual systems to pay civilians. Because of this multi-system environment, there are redundancies in systems maintenance, input and output formats, payroll coding structures, labor/accounting interfaces and associated reporting.

The Navy Standard Civilian Payroll System (NAVSCIPS) project was established by the Comptroller of the Navy with the primary goal of correcting these problems through a standard Department of the Navy (DON) civilian payroll system. The new system will offer many enhanced features to the payroll process. An area of concern that is a natural outgrowth of the system standardization is how the data is cclllected for input.

NAVSCIPS will be a single standard system using state-of-the-art dedicated minicomputers and software. The Navy

is applying information engineering, fourth-generation automated data processing (ADP) development techniques and modern data base management concepts with state-of-the-art hardware and data communication networks. Yet, the data that are required for this up-to-date system continues to be collected for the most part by a manual entry system on punch cards.

Today, the remarkable progress in micro-electronics technology has made office automation possible for any organization--including government activities.

B. ISSUE

In order to evaluate the desirability of automating the current payroll data collection system, several factors must be considered. The major factors are as follows: (1) the potential user acceptability, (2) the availability of funds, (3) the alternative uses of these funds, (4) the position of top management toward system implementation, and (5) an economic analysis of the costs and benefits of each alternative method. If the economic analysis supports an otherwise conducive environment, the expenditure will be justified.

C. THESIS OBJECTIVE

The objective of this thesis is to conduct an economic analysis of the present manual collection of labor data and a sample of automated alternatives in government and

industry. The other four factors in the decision process are situational and may vary within each command that evaluates automation. Therefore, they will not be addressed in the context of this economic study.

D. METHODOLOGY

The Naval Supply Centers at Oakland, California and Bremerton, Washington, were used to establish a model for the manual system as it exists in the Navy today. Field research was used to derive a sample of automated alternatives. The literature on automated systems and inputs from Department of Defense (DOD) project coordinators provided the basis of my sample. The key characteristics and costs are identified in each system in a manner that will allow economic comparison. The methodology deemed most appropriate for this analysis was a cost-effectiveness approach.

The cost effectiveness method involves the determination of the costs and benefits of each proposed alternative. Each proposed alternative has the basic capability to collect the time and labor data currently accumulated in the manual system. After specifying the objectives of the research a detailed cash flow analysis will be conducted. Benefits of each alternative that can be identified will also be included. Upon completion of the analysis, a preferred method will be chosen. The criterion used is to maximize the benefits minus costs, if they are both measurable in dollars or compatible units. If they are not,

a system will be chosen that will achieve a given performance objective at minimum cost.

E. THESIS OVERVIEW

The second chapter will discuss the process of economic analysis under the guidance of the Department of Defense Instruction on economic analysis and program evaluation for resource management. A format for the subsequent chapters will be developed as the analysis process is applied to this study. The third chapter will reflect the cash flow data accumulated on the present system in use at NSC Oakland and NSC Puget Sound, Bremerton. The data collection system will be broken into functional categories and presented with specific associated costs. The fourth chapter will discuss two successful payroll systems in the private sector and three in the public sector and their associated cash flows and benefits. The fifth chapter will present a comparative analysis of all of the data previously identified. Each of the system's cash flows will be totalled and their benefits discussed. The total cash flows identified will be converted to comparative net present values for their eight year economic life. These values will be compared and a selection made in light of the respective system benefits and other applicable considerations. The final chapter will summarize the study, draw conclusions, and recommend ideas for subsequent work.

II. AN ECONOMIC ANALYSIS OF THE NAVY PAYROLL SYSTEM

A. INTRODUCTION

Department of Defense Instruction 7041.3 on economic analysis and program evaluation for resource management defines economic analysis as follows:

> A systematic approach to the problem of choosing how to employ scarce resources and an investigation of the full implications of achieving a given objective in the most efficient and effective manner.

The process of economic analysis enables the analyst to propose alternative means of achieving an objective and investigating the cost and benefits of each of the alternatives. The six key elements of this process are as follows:

1. Establish a desired objective
2. Choose alternatives which will accomplish this objective
3. Formulate assumptions to support and reasonably limit the scope of the analysis
4. Determine the costs and benefits of each alternative
5. Compare the costs and benefits and rank the alternatives
6. Address those areas of uncertainty about the state of the world in the future

The analytic process differs somewhat in its application based on the needs of the particular program being evaluated. The six key elements will be adapted as they apply to this study on attendance and labor distribution data collection.

B. THE ELEMENTS OF ANALYSIS

1. Establish a Desired Objective

Only the first four elements of analysis will be covered in this chapter. The remaining elements will be covered in later chapters. The alternatives will then be ranked and general comments and conclusions made.

The objective of most managers is to best achieve the planned mission of their organizations in the most efficient and effective manner. One of the most crucial resources in the attainment of this objective is the productivity of their personnel. The quality of the work performed as well as the types of work performed are other available resources that the manager must constantly monitor. All of this information is currently available but not made easily accessible to management for their immediate use. "Personnel funds, in particular, are of paramount importance because civilian (payroll) costs amount to between seventy and eighty percent of a typical activity O & M,N budget." [Ref. 1:p. 10]

Before a manager can effectively pursue mission objectives, they must be able to identify the capabilities and costs of their work force. The accumulation of labor costs enable management to monitor work force productivity. The employee, as well, has a vested interest in the proper reflection of the amounts of time they spend on the job for proper reimbursement on payday. The desired objective for

analysis in this case is a source data collection system for input of attendance and labor distribution data that is cost effective.

2. Alternatives/Assumptions

Given the desired objective--a cost effective collection system for attendance and labor distribution data--the next step in analysis is to determine all feasible means of meeting the objective. Prior to commencing this portion of the analysis, a decision was made to focus this study on only automated alternatives to achieve the established objective. This assumes that the entire payroll system with which this data collection system will interface is being modernized with state-of-the-art hardware. There are a multitude of automated data processing (ADP) applications in existence today that reflect over and over again that the cost of hardware and mass storage has now dropped to the point where labor costs are much more significant than hardware costs. "Current technology provides the capability to store 105,000 business letters in the space of a desk drawer for less than $8,000." [Ref. 2:p. 33]

Two other significant assumptions must also be made in an economic analysis. The first is the economic life of any capital investment project. This is the period of time over which the benefits to be gained from a project may reasonably be expected to accrue. A maximum economic life has been established by the Department of Defense (DOD) for

automatic data processing equipment of eight years. Therefore, this will be reflected in the analysis. The research of systems currently being used in this field indicates this would be an accurate estimate for this particular study, as well. The life of the hardware may be renewed with a technologically more capable and many times, less expensive replacement. This would permit system effectiveness to continue beyond the life of the original capital investment. The life of hardware systems in the private sector tend to be of a shorter duration. However, this analysis is governed by DOD instruction 7041.3 and will therefore use the eight years as prescribed.

The second assumption is to determine the period of comparison. The period of comparsion is expected to extend through the time during which an asset will perform. The period of comparison will therefore be eight years to equal its economic life.

The automated alternative sites were chosen after an extensive screening of the literature on automated time and attendance systems. This appears to be a fairly new area of application for automation and therefore, few references were found.

The literature search was followed by a multitude of phone inquiries throughout the DOD as well as inquiries to commercial vendors. The Navy has recently consolidated the responsibility for its financial systems and their

standarization with NAVCOMPTSSA (Navy Comptroller Standard Systems Activity, Pensacola, Florida). Their personnel have conducted a major claimant survey to determine how various activities are collecting their payroll and labor distribution data. For the most part, manual systems prevail. However, there are several activities that are pursuing automation. Some examples are shipyards and the Construction Battalion Center at Fort Hueneme, California. It was also noted that the Naval Air Rework facilities have been under a system for years. Further study revealed that the Naval Underwater Weapon Engineering Station in Keyport, Washington, also has an automated collection system. Each system was independently conceived and there appears to be no uniformity of development, other than in the shipyard system (aside from recent efforts by NAVCOMPTSSA). The Naval Shipyard in Portsmouth, New Hampshire, maintains the prototype for the shipyard system and is coordinating the future placement in other shipyards.

The Air Force Accounting and Finance Center has taken a cursory look at the methods available and are considering optical mark readers for further development, but currently do not have a single automated system planned for implementation. Kelly Air Force Base has two systems, one for maintenance labor distribution reporting and one for their payroll. They are currently working up a locally developed system that will both consolidate and automate these systems.

Other types of commercial and municipal activities have various types of systems that are successfully in place. A sample was drawn from these activities based on the recommendations of three major system developers; National Cash Register, COMPUSCAN, and KRONOS Automated Time Systems. Each of these vendors was asked to recommend a customer with a currently implemented system.

3. Determine the Costs and Benefits

The Department of Defense, Economic Analysis Handbook, reviews the formal techniques for conducting a cost analysis. The objective of the cost analysis is to reflect all the resources that are required to achieve the stated mission objectives. The costs reflected for each alternative should be thorough and mutually exclusive. They must be reflected in the years they are expected to be incurred. Costs which have already been incurred at the time an analysis is made are "sunk costs" and should not be included in the comparison of the alternatives. The sunk costs will be annotated throughout the comparison in order that they can be eliminated in the implementation decision.

> There are three methods for analyzing costs (Industrial Engineering, Parametric Cost, Analogy). Two are supported by defined formal process. The third is largely dependent upon the judgment of the cost analyst. They are the parametric method and the analogy method. The appropriate estimating method must be determined and exercised by the analyst to arrive at the estimated cost of each alternative.... The adequacy of the cost analysis must be judged by the decision maker within the context of the problem. [Ref. 3:p. 7]

The Industrial Engineering Method consists of a consolidation of estimates from separate work segments. Estimating by this method is based on extensive knowledge of the system's characteristics. The analyst must have a detailed knowledge of the system in order that it may be broken down into its lower level components for the purpose of cost estimation. When detailed cost data is available, this is the best method.

The Parametric Cost Method bases its estimate upon ascribed physical and performance characteristics and their relationships to groups of costs. The analyst's job in this method is to choose and describe the cost influencing factors of the alternative. The data will be derived from the cost histories of prior programs. It is important that two points are made when this method is employed: (1) there is uncertainty inherent in the extrapolation of statistics and (2) the relationships proposed must be logically sound and reasonable.

The final method of judgment is called the analogy method. In this method, direct comparisons with historical information on like or similar existing systems are made. This appears to be the most widely used method of analysis to date, however, it is not the most accurate. Because it is basically a judgment process, it requires a considerable amount of expertise to be done successfully. The credibility of the results of this type of analysis will subsequently be affected by this judgment process.

The qualities which determine the extent of analysis necessary are as listed below:

a. Complexity of the problem

b. Predisposition of the decision maker

c. Importance of the project both in terms of mission and finances

d. The availability of qualified statistical analysts

The method chosen for this analysis is the analogy method. The Industrial Engineering method requires detailed cost data which was not available. Many companies in a competitive environment are very protective of price quotations and must also have the flexibility to negotiate with individual customers on matters pertaining to price and system complexity. Some of the activities evaluated did not have cost information easily available. The Parametric method requires costs histories of prior programs. This information was also not available. The systems evaluated had no predecessors of an equivalent nature.

The current system will be presented along with its associated costs. Other activities, both government and commercial, with payroll functions similar to our current system will be reviewed and the associated costs of their method of operation will be presented.

This method was chosen for several reasons related to the aforementioned criteria for the extent of analysis required.

a. The pay system is not a complex one. The transactions required are straightforward and can easily be presented for analysis.

b. The likely decision maker in this field will be a manager with an eye to cost effectiveness and not to a group of engineering standards associated with the accumulation of pay and labor data.

c. The decision is an important one as previously indicated, however, the choice of the actual method employed is not urgent nor its ramifications immense, in an isolated sight implementation.

d. The qualifications of this author are sufficient for this analysis.

e. The amount of time available for research will be limited.

In the application of the analogy method, a cost-flow will be presented over the eight year project life-span. Due to the time phasing of expenditures we must examine the effects of the time value of money on the investment decision. In order to do this, present values will be computed for future cash flows as appropriate.

Benefits associated with the various alternatives must also be addressed. The analysis of benefits is not as easily quantified as the costs. However, whenever applicable, they are included in the prsentation. In order to summarize and evaluate the associated benefits, a table has been included which reflects both quantifiable and non-quantifiable benefits. If we assume that benefits will be basically equal and therefore will not be a deciding factor, the alternative with the lowest amount of future cash flows would imply the more efficient allocation of resources.

The 10% discount rate required by the governing instruction (DODI 7041.3) will be used. This will allow an approximation of the value of the money to be spent, since these same funds would not be borrowed and interest on the deficit subsequently increased in the case of the Federal government. The discount rate represents an estimate of the average rate of return on private investment before corporate taxes and after adjusting for inflation.

An additional consideration in any cost comparison is the notion of the impact of inflation. There does not currently appear to be an approved process for handling inflation in this type of a study. A method that has been employed in other studies is the use of constant dollars. Constant year dollars are associated with a base year in order to adjust them to reflect equal buying power over the period of the analysis. Due to the relatively stable levels of inflation we have been experiencing and in order to keep the computations simple, this study will not convert costs into constant dollars.

III. THE PRESENT SYSTEM

A. INTRODUCTION

The present system as depicted in this chapter represents a consolidation of data accumulated through the review of labor and pay data collection operations at Naval Supply Centers Oakland, Ca., and Puget Sound, Bremerton, Wa. These systems have evolved out of the general guidance provided by the Navy Comptroller's Manual, volume III:

> Administration of the timekeeping function, as prescribed by the Commanding Officer of the payroll activity, with the provisions of this paragraph, is the responsibility of the Commanding Officer of each employing activity. It is the responsibility of the fiscal officer at the payroll accounting facility to devise uniform detailed operating procedures relative to documentation required to perform the payroll function for all activities paid which will provide effective control and ensure accuracy. Such procedures will be coordinated with the Commanding Officer of each employing activity and appropriately disseminated in accordance with local procedures. [Ref. 4]

B. OVERVIEW

All civilian personnel are currently required to prepare two cards on a weekly basis. One of the cards identifies all hours worked for the week in the general categories of regular time, overtime, sick leave, annual leave, etc., (See Appendix A). The second card identifies the job order numbers applicable to the type of work performed during each of their productive hours (see

Appendix B). The labor distribution data accumulated document the activity's use of resources and can serve as a planning aid in allocating those same resources. These data further serve as a cost control tool by maintaining their visibility and allowing the detection of unproductive trends.

Management reports are created for the analysis of funded man-years (equates dollars spent on civilian labor to the number of full-time equivalent man-years.) Reports that determine the status of command funds subsequent to the pay period are also created. Funds are reprogrammed based on this information.

The Navy currently has no uniform plan for numbering job orders because of the diversity of functions at the multitude of activities within the Department of the Navy. Job order number length depends on the level of detail desired in cost accumulation. However, there are basic functional codes, which help to meet restrictions made by Congress or other outside parties, that are standardized throughout.

New time and labor cards are issued to the activities from the Data Processing Department of the Supply Center. The time-keepers designated at each activity distribute the cards to all employees. The number of time-keepers designated at each activity varies with the size of the civilian employee population and their geographic location.

The completed cards are certified by the supervisor and collected for turn-in to the Supply Center's labor distribution and payroll collection points on the scheduled date prior to payday. The time-keepers will insure that time periods, job orders and valid employee names are properly entered prior to their submission to the paying office.

The central paying activity, known as the Authorization Accounting Activity (AAA), collects the time cards and labor reports (which may be completed in various formats). The labor cards must then be keypunched and processed. The Civilian Pay Branch reviews the time cards. They must ensure that a card is received for each employee, that appropriate payroll adjustments are made to ensure correct payment to the employee, that a required certification signature is present, and that the required initials for entries exist or appropriate forms are attached. These cards are then directly entered by payroll personnel into terminals located in the payroll area. In both cases, the names of employees are compared with a master list to ensure only valid cards are further processed.

The Naval Supply Center Oakland Instruction 7410.2J, Civilian Payroll and Labor Distribution Handbook, includes approximately thirty different formats for the completion of time cards and labor distribution cards under various circumstances. Therefore, the review of submitted cards is only a cursory one at this point. After all labor cards

have been keypunched and processed and all entries have been made by the payroll clerks, the input will be transferred to disk and then dumped to tape. The tape is then forwarded to another branch within the data processing department to be run in accordance with the schedule established by the Financial Management Staff of the AAA.

The outputs generated from the two inputs, labor and payroll, must be reconciled in total subsequent to processing. There is a great deal of effort expended to ensure that only appropriate labor charges, accurately calculated, are charged to government funds.

A labor/exception reversal list and exception cards (see Appendix C) are generated when errors occur. The Cost and Allotments Branch must reconcile all errors. The most common types of errors are as follows:

1. A difference in excess of $1.00 within category between the labor distribution and gross pay tape
2. An invalid cost account
3. An invalid job order number

Each of these errors must be reconciled with the Group Activity department supervisor responsible if they cannot be resolved by the Cost and Allotments Branch.

C. COST IDENTIFICATION

The following subsections will review the process of time and labor data collection in detail. Costs will be associated with each process identified. The final summary

of alternatives will provide a graphical representation of these costs in a format that will allow comparison with the other systems evaluated.

1. Activity Costs

Naval Supply Center, Puget Sound processes payroll data for approximately fifty different activities. Naval Supply Center, Oakland processes payroll data for ninety five different activities. Every two weeks approximately 12,000 people are paid at these activities. In order to simplify the analysis, a satellite activity, the Naval Postgraduate School (NPS), was chosen to reflect typical activity costs.

Each one of the activity's personnel spends time every week on the completion of the two input cards. This represents nonproductive time in an employee's day. It would be difficult to place a total dollar value on this time. However, the average amount of time you could expect an employee to spend on this activity would be thirty minutes a week. Out of a work-year of 2080 hours, this does not appear to be significant.

Typical satellite activity routine commences approximately Wednesday prior to the Friday before a payday. The employees of the activity turn all labor and time cards into department representatives to be collected for further transmission to a centralized timekeeper. The time-keeper at the Naval Postgraduate School spends one and a half days in the review and preparation of these cards before they are

transmitted to the AAA for processing. The time-keeper checks various points of information on the two cards to ensure basic validity. An employee master list is maintained on a small computer, to ensure that all employee time and labor cards are accounted for. These cards are then segregated by groups and put into alphabetical order. Adding machine tapes are run on various pay category totals. Employees are contacted if discrepancies are discovered. The cards are then packaged and forwarded by various means to Oakland and Puget Sound by their outlying activities. The price of this transmission will vary according to the method used. The Naval Postgraduate School forwards their cards by Greyhound bus to Oakland every payday at a cost of $5.80.

After time and labor cards have been processed by the AAA, the time-keeper will spend an average of eight hours in the process of clearing exceptions created by errors in the previously submitted cards. These hours were accumulated in the processing of 1,260 cards at the Naval Postgraduate School. The amount of time required by activity time-keepers will vary with the number of employees and the capability of the time-keepers. The activity time-keeper position is generally a GS-4 and will be valued at $6.00 per hour.

2. Cost and Allotment Branch of the AAA

NSC Oakland receives three types of inputs:

a. ZPX cards - one for every person at the user activity

b. ZNX cards - one for every person at the user activity

c. ZNX labor distribution summary sheets - combines various labor groups.

The activity commanders will decide which document will be used by their personnel.

The labor cards are handled differently at the two processing centers evaluated. NSC Oakland's system will be presented because it has centralized the function, which facilitates cost identification.

An accounting technician receives the ZPX cards from all submitting activities. The cards are screened for obvious errors, then batched and sent to the key entry section of the Data Processing Department. The cards are key punched and returned to the Accounting Technician with a listing which reflects the contents of the cards. The actual amount of time spent per batch in this process varies with the quality of the input. (Quality appears to vary with each activity.) The Accounting Technician estimated that her time spent on this activity per pay period is eight hours.

The ZNX forms and the ZNX cards received from remaining activities are also screened. Certain areas are checked on each document and the number of cards is verified to ensure all cards are accounted for. All retroactive payroll transactions (generated due to error from the previous period) as well as the current ones are reviewed.

The estimated amount of time associated with these documents per pay period is 16 hours.

Once the cards are punched and processed, exception cards are generated. Many of the adjustments required are made by the Accounting Technician. It was estimated that approximately 3,000 - 4,000 adjustments are required per pay period. This is a large number in relation to the eight thousand pay checks that will be produced. Over three days, a total of eight hours of the Accounting Technician's time will be spent on this activity. Typical errors consist of the following: the use of improper job order numbers, the handwriting on input cards is not legible, and mismatches between labor and payroll totals due to special pay arrangements such as overtime or night differential. Any corrections that cannot be made at the branch will be returned to the customer activity for resolution. A labor transaction ledger is also maintained by the Accounting Technician in association with card maintenance and control. This function consumes approximately five hours per pay period.

Approximately four hours per day are spent on mailings. (The receipt and transmission of cards, corrected cards, listings, etc. from both data processing and customer activities.) In addition to the handling of documents, the technician will spend at least a total of one hour per day, every day, in customer service. This includes such activities as answering questions about the proper handling of labor cards.

The Accounting Technician position is generally a GS-5 or GS-6. The wage rates vary from $6.66 - $8.66 per hour for a GS-5 and from $7.43 - $9.66 per hour for a GS-6. The employees' experience on the job has a great impact on the number of hours required to perform this job. The estimated times used in this study were associated with an employee who had an average amount of experience and an above average ability. An average wage rate of $8.50 per hour will, therefore, be used for the analysis.

3. Civilian Pay Branch of the AAA

The payroll clerks will vary in number according to the number of employees paid. They are responsible, generally, for approximately 550 customers each. Less well trained clerks will be unable to handle this size of a load initially. (Turnover of payroll clerks is notably high--the associated costs of lost time are difficult to compute but should be noted.) The Supply Center at Puget Sound has seven payroll clerks and three payroll technicians. Oakland has sixteen payroll clerks and three technicians. This reflects the fact that their work load is double that of Puget Sound's. In order to maintain the continuity in estimating hours associated with a given work load, we will continue to use the Oakland organization. The payroll clerks range in pay grade from GS-3 to GS-5. The wage rate for a GS-5 is $6.66 - $8.66 per hour. Of the sixteen clerks at Oakland, only one was not a GS-5. Therefore, we will use

the average rate of $8.00 per hour for these labor hours as well. The accounting technicians are generally GS-6 wage rates. Their hours will be weighted at $8.50 per hour.

The typical branch payday routine commences noon of the Friday before payday. The time cards are turned into the central collection point at the Supply Center. Puget Sound has also incorporated a procedure to time stamp the cards when received because of the problems associated with late or missing cards. When the cards have been stamped upon receipt, the Supply Center can properly affix responsibility for late cards. This adds an additional amount of handling costs to the cards. It takes approximately two hours total for 4,000 cards. The cards are distributed to their respective payroll clerk by the customer service section of the payroll branch. The technicians will spend several hours in the distribution process. During the three days prior to the payroll run, approximately twenty four hours in total will be consumed. Upon receipt of the time cards, the payroll clerks will perform the following:

a. group the cards in social security order number sequence (required by the software which currently accepts payroll data input),

b. categorize and total all sick leave, annual leave and overtime,

c. make corrections to obvious errors or contact activity representatives,

d. input the card data into the terminal.

A large amount of time is required to ensure all data has been input correctly prior to the final payroll run on Tuesday evening. All payroll clerks are required to work three hours of overtime on the Monday prior to payday. In addition, four clerks are also required to work an additional three hours of overtime on the next day. Overtime for regular full-time employees will be time and a half. This applies to all GS-1 to GS-10 employees up to a ceiling amount provided by law. The adjusted rate which must be applied to these hours is, therefore, $12.00 per hour. This is computed by taking one and one half times the average rate previously identified for the work of a GS-5 payroll clerk--$8.00.

When the information is subsequently processed, a listing of errors is created and the payroll clerks must then make the necessary corrections. The estimated time for these actions are six to ten hours per pay period. We will use a mid-range figure of eight hours.

Upon completion of the payroll process all time cards must then be filed for retention as required by law. This requires storage space to handle all employees' cards for every pay period over a total of six years.

4. Automatic Data Processing Branch of the AAA

The labor distribution cards batched in group activity departments are logged in upon receipt in Data Processing at the Puget Sound location. These are

subsequently split into batches of 200 cards to be given to the various key punch operators and the contractor. Approximately nineteen regular time hours, and twelve over-time hours are required to process 3,000 cards. The typical keypunch operator is rated a GS-4. In addition to the in house keypunch operation, a contractor is paid $700 every two weeks to punch cards that are handled on a regular basis. An additional eight hours are spent in the handling and control of the cards.

NSC Oakland processes 48,000 cards per month at a contract cost of $.062 per card, for a total of $2,976.00 per month. The actual cost of the cards at 2100 cards per box and $59.93 per box and nine boxes per month totals approximately $550.00. Upon completion of payroll processing, the Data Processing Branch retains the labor cards on file as required. The holding costs for the storage of these cards is also a difficult cost to compute. No other costs could be identified directly with the processing of labor cards.

IV. THE AUTOMATED ALTERNATIVES

The process of economic analysis continues in this chapter with the description of various automated alternatives to the present system presented in Chapter Three. All of the sites evaluated in this chapter have equipment that is adaptable to the requirements of the pay system at the Naval Supply Center. The various locations evaluated reflect an environment that is similar to the Supply Center in many ways. Some of the similarities are: the variety of schedules, the diversity in locations of employees, the wide range in types of personnel serviced by the pay system, and the need for current and accurate information.

In addition to the general description of the various systems, specific costs associated with each alternative will be reflected. The costs will be segregated into three major categories: (1) one-time costs, (2) fixed costs, and (3) variable costs. A one-time cost denotes that this cash flow is only expected to be incurred at the initial implementation of the system. A fixed cost denotes a cash flow that is expected to be constant throughout the life of the system regardless of the number of employees serviced by the system. Variable costs denote cash flows that will vary with the number of employees serviced at the activity.

The next chapter will present a comparative analysis of the five alternative cash flows and those of the present

system. This analysis will adjust the individual cash flows identified in this chapter to the size requirements of the Supply Center whenever necessary.

A. THE KRONOS, INC. - SYSTEM 55

1. System Description

Kronos has patented a microprocessor-based clock to read coded entries on a worker's time card, calculate how many hours have been worked, and relay that information to a computer in the payroll department. The microprocessor reads the worker's identification code at the bottom of the time card. The code is like a crossword puzzle: darkened squares in a matrix. The microprocessor can read a time card, send information to the central computer, and accept commands from a keyboard almost simultaneously.

Kronos has two primary systems, the Timekeeper 70, which is an input device that uses a form of time card, and the Timekeeper 55 which uses badges that may have three types of encoding: a) Hollerith punch holes, b) optical bar code, or c) magnetic stripe.

The Kronos Timekeepers operate in a stand-alone or communicating application. If the system is connected to a personal computer, many of the functions are done through the connected video display terminal. All of the scheduling, editing and requesting of management reports can be done at one central location.

The system evluated was a Timekeeper 55. The Timekeeper 55 allows a maximum of 500 regular employees per clock in addition to another 1000 intermittent entries from random employees. The Timekeeper 55 is an updated version of the 70 and collects the employee punch data without the aid of the central computer. This off-line approach enables the computer to be used for other functions while the terminals continue to collect data.

Several safety measures are built into the system:

a. Battery backup in case of a power failure

b. A rugged design to function in harsh environments

c. A keyboard for manual input when an employee forgets their badge

The Timekeepers come with a standard software package that is adapted to the client's requirements. The Timekeeper 55 may be located up to 4000 feet from the central computer. The hardware is IBM compatible and uses a BISYNC mode of communications. The system requires a simple house ground on a "clean" line (no other large pieces of equipment on the line.) Up to 31 Timekeepers can be connected to any one PC. The Timekeeper 55 is expected to have a longer time between failures than the Timekeeper 70. Currently, West Coast experience for the Timekeeper 70 has been 36 months. The Timekeeper 55 has not been in the field long enough to allow an exact determination of how much longer it will last between failures.

2. System Costs and Benefits

The actual system site evaluated was a Wards Department Store located in Fremont, California. The following paragraphs reflect the costs and benefits of this system.

One of the primary benefits of this system is that it automatically prevents employees from collecting unauthorized overtime. Parameters set into the microprocessor prevent employees from punching in earlier or later than their regular schedule, without supervisor authorization. The significance of this benefit cannot be overemphasized. A survey of 500 personnel directors and managers was conducted in 1980 by Robert Half Personnel Agencies, Inc. Respondents were asked about their impression of time theft in their companies. The results indicated time theft averages four hours and eighteen minutes each week for each employee. That amount results in a 120 billion dollar loss per year. This can be compared to the cost of typical white collar crimes--embezzlement, kickbacks, shoplifting and computer fraud--which comes to about forty billion dollars. "Half's results could have been much worse, except government employees and management are not included in the questionnaires. The former are the 'biggest time thieves of all', he says, ..." [Ref. 5:p. 25]

Another benefit of this particular system is that it can be integrated into an existing central computer system. This would allow a potential user to eliminate the

additional costs of a central terminal if they presently have a system in use.

In addition to these benefits, the clock also automatically totals labor hours, calculates overtime and compiles reports on attendance. The system helps managers keep track of absenteeism and tardiness on a real-time basis. To generate a report, the manager need only insert his/her supervisor card in the microprocessor and punch in a two-digit code. A blank card is then inserted and the system can print a list of employees who didn't punch in that day. By pinpointing these problems early, a manager can more easily gain improved productivity because of the ability to take action immediately. The advantages of this acquired accuracy and information access are great.

Appendices D and E indicate the general costs of lost time and calculation errors. Appendix D indicates the cost impact of only five minutes of lost time per employee per day. Appendix E shows what a one-half percent error rate can mean to a company annually in overpayments to its employees.

The costs incurred at this location were as follows:

a. One-Time Costs

1. $7,000 for the IBM PC to function as the central collection terminal
2. $4,000 for the software which provides for the management reports, allows punch restrictions to be placed in the system, etc. Training on the equipment with the installed software is included in this cost.

b. Fixed Costs

1. There is a 90 day warranty on the equipment. Maintenance contracts are priced as follows: $250 per year for the hardware maintenance; $300 for the software maintenance.

2. The store personnel manager has been assigned responsibility for the system. Employees currently working for Wards will be responsible for updating the system's information base. These duties will partially replace the time previously spent on clerical duties associated with the old time card method. The work load for schedule updating equates to approximately two hours per day because each department manager has the flexibility to alter each of their employees hours. There are no additional costs associated with the management of the system.

c. Variable Costs

1. $2,200 for the Timekeeper which was placed in a central location where a mechanical time clock had previously been located. All 280 employees use this location for all transactions. The associated wiring of the equipment was a one hour job with minimal costs for materials.

2. Credit card badges are maintained in racks near the timekeepers. Badges can be acquired through several different manufacturers. Toye Corporation of Chatsworth, Ca., has a variety of cards that can be personalized to the system at a price range from $2.50 to $4.00 each. Initial one time costs for set up vary with the style chosen ($200-$300).

B. COMPUSCAN OCR SYSTEM - COUNTY OF ALAMEDA

1. System Description

COMPUSCAN, based in Fairfield, New Jersey, installed the source data collection equipment in the Data Processing Department of the County of Alameda. Their equipment, known as the OBM Laser Series, is a combination page/document Optical Character Reader (OCR) which speeds up data entry

scanning and capturing. The rate of processing varies from 402 to 4400 documents an hour depending on the length of the document and the number of lines of data. This process eliminates the need for keypunching. Numeric data that has been typed, marked, machine printed or hand printed on forms can be scanned and batched directly to mainframe computers.

The County's primary use of the equipment was in the processing of payroll documents. The Data Processing Department created Time and Attendance forms imprinted with employee names. These forms were separated and forwarded to the payroll clerks biweekly for further distribution to the various employees.

In addition to the time sheets, additional forms were created for the accumulation of job order numbers which were used to identify the distribution of productive hours. The Public Works Office of the County was the primary user of job order numbers.

2. System Costs and Benefits

There are several benefits to this particular system as follows:

a. Typists and other personnel who are not trained on specialized equipment can effectively prepare input data and use the system.

b. Equipment compatibility is not essential. The data can be properly formatted and routed to a number of incompatible information processing systems, such as hard or floppy disks, magnetic tapes, modems, etc.

c. A high degree of accuracy is made possible by laser technology. (A high quality light source that enables it to read otherwise unscanable documents.)

d. Multiple operating modes are available which allow on-line or off-line editing for rejected documents.

e. Maintains several user tailorable editing capabilities to allow initial input document review prior to its inclusion in the final product.

The costs associated with this system are as follows.

a. One-Time Costs

The specific cost associated with their equipment model was a purchase price of $102,500. A newer updated model of this same equipment is available for $87,500. Two to five year leases are available, as well, for $1800 per month.

b. Fixed Costs

All employees were required to complete a time and attendance sheet. These were collected by the various office timekeepers upon completion and returned to the payroll clerks. There were approximately 200 people involved in this process. Each time-keeper/payroll clerk was responsible for different numbers of personnel, however, it was estimated by the Personnel Manager that each spent two full days in the entry of time and labor distribution data. The skill levels varied within a monthly range from Clerk 1 ($1054-1194) to a full-time payroll clerk ($1242-1470). A mid-range figure of $1250 will be used to value the associated system labor.

Approximately 10,000 employees are processed over three days. Out of 10,000 input forms, approximately 1,000 errors will occur on the average. When the process is handled off-line, the rejected forms will be collected for later collection and the equipment will continue to process valid inputs. A minimal amount of operator interface is required. The operator can be a low-level programmer or terminal operator drawn from current resources. The forms used by the County were processed at the rate of approximately 540 per hour.

In addition to the hardware costs, a standard maintenance contract is available for $800 per month. The service includes a monthly preventative maintenance check and service calls once every six weeks. The initial training and a 60 day break-in on the equipment is included in hardware costs.

c. Variable Costs

Upon receipt of the time sheets in the pay office, the clerks would edit the inputs of the various departments and enter the data on the OCR documents. Each OCR document can contain information on more than one employee. The completed forms were then sent to data processing. Form prices vary with the quantity purchased. An average price for the expected quantities required by this system is $70 per thousand forms.

C. NATIONAL CASH REGISTER - WESTINGHOUSE

1. System Description

The next two alternatives are sites that both use National Cash Register (NCR), Dayton, Ohio, Data Pathing equipment.

Westinghouse of Sunnyvale, California, implemented their system in 1983. They currently use the model 2830 Industrial CRT Display Station for the collection of hourly labor distribution information. At this time, Westinghouse has chosen to defer using the system to create their payroll until the current implementation for labor collection is complete and debugged.

The hardware consists of a unit that helps to ensure reliable operation in the hostile industrial factory environment. The keyboard consists of oversized keys and operator prompting features which allow efficient use by all levels of employees. A key entry bypass allows employees to use badges, cards, or a bar code wand. This provides faster and more accurate data input. A photo-optic reading process ensures reading of cards in poor condition as well. The software allows customer preferences to be reflected in such features as levels of intensity, size of characters, and definition of screen fields.

Westinghouse currently has three shifts of employees totalling 550 personnel that use the system. When the system is installed plant-wide, there will be 900 employees

using the system. Approximately sixty terminals support their plant which covers 88 acres of land. These terminals were located based on geographic considerations such as where data lines could be run and their desire to have ten people per terminal. Each employee uses the terminals to log on to each new job they work on during the day. Employees punch in and out of the work day at a separate location for payroll purposes. Once the information is registered at the shop terminal, it is recorded on magnetic tape in the CPU. It is subsequently read by the host computer to update system files and generate output reports.

The central processing unit is housed in the main computer systems office and it requires only occasional attention unless major problems develop. During busy times at the terminals, cues allow accumulation of data without slowing down response time. Generally, transactions are completed in nor more than 15 seconds.

The system has a good up-time ratio and a maintenance contract is maintained on the leased equipment. Various management reports are produced from the data on a routine basis as well. The accumulation of cost data is very important to the contract type of work done at Westinghouse. The system's real-time collection of time and job information allows supervisors to display data immediately after a shift begins. This information indicates who is present and what jobs are being worked.

2. System Costs and Benefits

Benefits associated with the equipment are as follows:

a. Minimal errors in the data collected

b. Timeliness of the information access

c. Front end editing with an alphanumeric display for prompting and error messages

d. Each terminal operates independently of the others which allows continual processing at other terminals even if one malfunctions.

The costs associated with this system are as follows.

a. One-Time Costs

Hardware costs: lease $177,252/yr purchase $528,295

Itemized hardware:

1. 1510 Processor Group: System Console, 320 KB Memory, (2) Tape Drives, 60 MB Disk Drive, IBM 3270 Interface

2. Terminal/Peripheral Group: (6) Model 3743 Mit Controllers, (3) Model 3744 Mit Controllers, (51) Model 2830 Industrial CRT Terminals, (15) Model 2831 Office CRT Terminals, (18) Model 2806 T/A Terminals, (2) Model 2872 Bar-Code Printers

b. Fixed Costs

1. Maintenance contract $63,576/yr

2. Personnel $600/wk

c. Variable Costs

1. A wooden hutch designed and constructed for each terminal at a cost of $500 each. Two types of line were required to connect the terminals. The net cost per terminal was $800. Thirty to forty hours of labor were required for the entire installation.

2. Badge Costs $.75 each

D. NATIONAL CASH REGISTER - NUWES SITE

1. System Description

The Naval Undersea Warfare Engineering Station (NUWES) in Keyport, Washington, also uses an NCR system. They have been using their system since 1975. In addition to the daily time-keeping function, they also use the system for field inquiry, supply files, quality assurance tracking, technical files, field engineer's inventory and preventive maintenance. They have additional applications planned to use up the remaining sixty per cent of disc capability remaining.

The NUWES equipment differs from Westinghouse's in that the terminals used are a different model oriented toward ease of file inquiry and an office versus industrial environment. Error feedback and acceptance information are provided by the terminal prior to releasing the operator's badge from the input slot. This helps to ensure a high degree of accurate data input.

The hardware at the NUWES location consists of two CPU's and 89 time and attendance terminals for 4000 people. Their experience with the system reliability has been excellent. The speed has also been a significant factor in employee acceptance. Each terminal can handle up to 1600 transactions a minute. Each CPU can handle 150 terminals.

Typical work day routine consists of all employees clocking in with a Hollerith punched badge. The employees

may also at the same time punch in a job order number or irregular pay codes, if annual leave or other types of transactions are expected. Typical training sessions with new employees last approximately one and a half hours.

Once the information is collected, it is put to tape. There are nine payroll clerks who subsequently process the information. There are two individuals responsible for the system software and coordinating the contract maintenance work.

A single pair of phone lines is required per terminal and dedicated 110 volt power. The hardware installation is done by the company.

2. System Costs and Benefits

The benefits of this system will be the same as those identified in the Westinghouse NCR system and will not be repeated.

The costs associated with this system are as follows:

a. One-Time Costs

1. Central Processing Units 2 at $48,500 ea
2. Printers 15 at $1,800 ea
3. Tape drives 3 at $14,000 ea
4. Disc processor $42,000
5. Disc controller $9,000
6. 60 mg. disc memory $45,000

b. Fixed Costs

1. Maintenance Contract $23,500/yr
2. personnel 1.5 persons for $5,100/mo

c. Variable Costs

1. Badges $.75 ea
2. Benches $500.00 ea for 89 terminals
3. Terminals 21 at $1400 ea
4. Transacters 89 at $5800 ea

E. TANDEM NETWORK - NARF, ALAMEDA, CA

1. System Description

The Naval Air Rework Facility (NARF) in Alameda, California, has employed source data automation equipment since 1982. Five thousand employees in total are located at this site. One thousand of these personnel are supervisors and are exempt from the clocking system. The activity maintains 175 transacter recorders for the use of the remaining personnel.

NARF uses a Tandem system of terminals with keyboards and card readers. These terminals are connected to four processors with basic software capabilities to allow for data editing and polling from the various terminals. Each employee enters the system daily with a Hollerith punched card the size of a credit card. This small card simply identifies the employee. If the employee is also commencing work on a specific job, a plastic eighty column job card is also placed into the terminal's card reader. These cards are located in racks near the terminals.

The information collected is subsequently fowarded electronically to their UNIVAC computer each evening. A

Daily Labor Exception Report is created for supervisors to ensure all entered data are authorized. Supervisors may also use the terminals to do on-line inquiries of collected data in a variety of formats.

NARF's automated system currently parallels their old manual system to ensure a smooth transition. However, the activity believes that the information made available has justified the hardware costs.

2. System Costs and Benefits

There are no unique benefits associated with this system. All of those previously mentioned of a general nature apply.

The costs associated with this system are as follows.

a. One-Time Costs

1. Central Processing Units 4 at $123,400 ea
2. Associated peripherals $500,000
3. Punch machines 2 at $2,200 ea for additional card creation
4. Hollerith punch 1 at $8.500 ea machine for coding new cards
5. Software provided by the Central Design Agency for all Naval Air Rework facilities.

b. Fixed Costs

1. Operations support contract $160,000/yr
2. NALC Hardware maintenance contract $300,000/yr

c. Variable Costs

1. Tandem terminals 175 at $6300 ea
2. Identification cards $.23 ea
3. Job cards $.35 ea (The price of cards varies with the quantity purchased.)
4. Installation Unable to identify costs

F. SUMMARY

This chapter has delineated the essential costs and benefits associated with each of the five automated alternatives to the present manual system. This information must now be standardized in order that a comparison can be made between the alternatives. The following Chapter will convert these cash flows into present values, analyze benefits and adapt the alternatives to support an organization that resembles the Supply Center at Oakland. The final analysis will conclude with a recommended method of operation.

V. COMPARATIVE ANALYSIS OF COSTS AND BENEFITS

The purpose of this chapter is to discuss the criteria for comparative analysis and present the results of analysis. In addition, a summary of results will be included.

A. CRITERIA FOR COMPARATIVE ANALYSIS

There are three basic types of cost/benefit relationships: (1) unequal cost/equal effectiveness, (2) equal cost/unequal effectiveness, and (3) unequal cost/unequal effectiveness. The ranking of alternatives is based upon these relationships. The criteria which correspond to these relationships are: (1) least cost for a given level of effectiveness, (2) most effectiveness for a given cost constraint and (3) largest ratio of effectiveness to cost.

To determine which one of these criteria should be employed, the analyst should consider the following:

1. Unequal Cost/Equal Effectiveness--This method requires that alternatives have the same level of benefits. The alternative with the lowest discounted cost should then be preferred.

2. Equal Cost/Unequal Effectiveness--This method requires that it be possible to adequately reflect the benefits so that a comparison can be made. The alternative with the greatest benefits for the given budget level should then be chosen.

3. Unequal Benefits and Unequal Costs--If the benefits of a higher cost alternative are judged to be greater than lower cost alternatives, the additional cost to attain the level of benefit would need to be justified. This method tends to diffuse levels of expenditure and relative capabilities of the alternatives. It should only be used when costs or capabilities are reasonably close for all of the alternatives.

The criterion of least cost for a given level of effectiveness was chosen for this analysis. This criterion was chosen for the following reasons: (1) each system evaluated will achieve the stated mission objective--provide a source data collection system for input of attendance and labor distribution data, and (2) the associated cash flows for each alternative are different and are currently not limited by a budget constraint.

B. SYSTEM CASH FLOW ANALYSIS

To begin this comparison, the cash flows of each alternative will be presented for the eight year economic life of the systems. The cash flows reflected for each of the automated alternatives have been adjusted to accommodate the requirements of paying the 8,000 employees currently under the manual system at NSC Oakland. The actual adjustment made in the automated systems allows for the payment of only 80% of this number. This adjusted number was used because each of the automated systems automatically includes non-hourly personnel without further input. If we assume that approximately 20% of the total number of employees hold management positions, hardware will only be necessary for 6400 employees (80 X 8000). These adjustments will be discussed further in the text accompanying the tables summarizing the cash flows for each system. The amounts reflected will then be converted into present values, using the 10% discount factor specified in the DOD Instruction.

It is difficult to accurately estimate these costs without a detailed study by the responsible system representative. Therefore, several approximation processes will be used to estimate these figures. The number of input devices required to post daily attendance and labor data will be estimated using a linear relationship between the numbers of employees currently using the system and the number of input devices currently employed, unless a better means is available. All assumptions will be identified. The peripheral equipment expansion will be based on the equipment limitations for the number of terminals that can be serviced by a single hardware unit. The actual number of equipment employed will vary with the command's preferences and any budget limitations incurred.

Following the presentation of costs, benefits will be discussed and evaluated. The impact of benefits will be reflected as adjustments to the discounted cash outflows. The net discounted cash flows will then be reflected. The alternatives will then be ranked according to the criteria of least cost for a given level of effectiveness.

1. Costs of the Present System

The following paragraphs summarize the information presented in Chapter III. All of the information describing the manual system will be condensed into calculatios to provide a total cash flow.

a. Local Activity:

Labor: 12 hours for initial review and preparation of cards
8 hours for processing exceptions

Total: 20 hours X $6/hr X 26 pay periods = $3,120

Eight thousand employees are paid by the AAA in Oakland. Each employee submits two cards each pay period, unless additional cards are required to accommodate all of the labor data accumulated by the employee. A total of 16,000 cards are subsequently handled per pay period. If we assume that the Naval Postgraduate School labor costs are typical for the processing of 1,260 cards, these amounts must be multiplied by 12.7 (16,000/1,260). This will not be an exact reflection of the labor costs actually incurred because timekeepers are designated in a variety of ways that reflect the convenience of the command. However, the total average time required to perform this function may be approximated by this calculation:

Labor: $3,120 X 12.7 = $39,624 (adjusted)

Card Transmission to the AAA: $5,80 per pay period X 26 pds.
= $151

These amounts were based on the processing of 1,260 cards. They must be expanded to reflect the total cost associated with ninety-five activities. The following calculations were therefore made to include these costs. Since the 95 activities must transport their data to the AAA by means that will vary by location, it is not feasible to determine the exact cost data without examining the transmission methods used by each of the 95 activities. This is, of course, beyond the scope of this study. Therefore, the $5.80 will be multiplied by 26 pay periods per year times the 94 activities which are

external to the Supply Center itself. This figure will provide a reasonable approximation of the total costs incurred by all of the activities.

Card transmission: $151 X 94 = $14,194 (adjusted)

b. AAA Cost Allotment Branch

Labor: 10 hours customer service
40 hours mailings
8 hours ZPX card initial screening
16 hours ZNX form/card initial screening
8 hours data adjustments
5 hours labor transaction ledger

Total: 87 hrs X $8.50/hr X 26 pay pds. = $19,227

c. AAA Payroll Branch

Labor:	Receipt of Cards	$8.00/hr X 4 hrs X 26 pay pds.	= $832
	Card Distribution:	$8.50/hr X 24 hrs X 26 pay pds.	= $5,304
	Card Processing:	16 clerks X 16 hrs X $8/hr X 26 pay pds.	= $53,248
		16 clerks X 3 hrs X $12/hr X 26 pay pds.	= $14,976
		4 clerks X 3 hrs X $12/hr X 26 pay pds.	= $3,744
	Error Correction:	$8/hr X 8 hrs X 26 pay pds.	= $1,664
Total:			$79,768

d. AAA ADP Branch

Labor:	Keypunch (in-house):	$6.00/hr X 19 hrs X 26 pay pds.	= $2,964
		$9.00/hr X 12 hrs X 26 pay pds.	= $2,808

Keypunch (contract): $2976/mo X 12 mos = $35,712

Card handling and control: $6.00/hr X 8 hrs X 26 pay pds. = $1,248

Total: $42,732

Card Cost: $550/mo X 12 mos = $6,600

e. Summary

1. Labor: Activity	$39,624
AAA--Cost Branch	19,227
AAA--Payroll Branch	79,768
AAA--ADP Branch	42,732
Total Labor Cost:	$181,351
2. Card Cost:	$6,600
3. Card Transmission:	$14,194
Grand Total:	$202,145

In order to present the information in a format that will allow comparison, the costs over the eight year economic life of the analysis are summarized in Table 5-1. In every case, the costs are assumed to be recurring over the entire eight year period. In the previous discussion of the manual system we also noted that the additional costs of storage and employee time for the completion of the time cards were difficult to compute. It is important to recognize them at this time as well.

2. Alternative System Costs

The following information summarizes the data presented in Chapter IV. The alternative automated systems will be evaluated based on outright purchase. However, each alternative

TABLE 5-1

COSTS OF THE PRESENT SYSTEM

COSTS	YEARS 1	2	3	4	5	6	7	8
Labor	$181,351*							
Cards	6,600*							
Transmission	14,194*							
Total	$202,145*							

*Same annual costs assumed for each year

may also be leased at various monthly rates and this option remains open to any activity considering automation.

a. KRONOS--Timekeeper 55

The costs of this system identified at the Wards location were as follows:

Hardware:	IBM-PC	$7,000
	Timekeeper	2,200
		$9,200

Personnel: 2 hours/day X $8.50/hr X 260 working days = $4,420

Badges: $3.25 ea

Maintenance: Software $300/yr

Hardware $250/yr

In order to expand this system to reflect an estimated cost of the size required to service the 6400 employees of the AAA, the following adjustments were made:

(1) Additional Timekeepers

The Naval Supply Center in San Diego is currently working with KRONOS to estimate the number of terminals required in their environment. They have estimated that there should be 50 employees per terminal. To determine the additional costs of Timekeepers, the following computation was made: 6400/50 = 128; 128 less one unit included in the present data equals 127 additional timekeeprs required. The total cost associated with this acquisition will be 127 X $2200 = $279,400. (This price is an estimate that will be open to negotiation with the company due to quantity discounts, etc.)

(2) Additional Processors

Three additional processors would be required to accommodate the additional Timekeepers. Each IBM-PC can accommodate 31 Timekeepers. The cost of the additional processors is estimated as follows: 3 X $7000 = $21,000.

(3) Additional Maintenance

The actual amount associated with this contract is difficult to estimate accurately. The amount of maintenance currently charged at the Wards location is for one Timekeeper. Therefore, to compute a reasonable estimate the additional 127 terminals will be multiplied by $250 each for a total of $31,750.

(4) Badges

To accommodate the 6400 employees, the $3.25 cost per badge is multiplied by this number. Therefore, the cost of badges is $20,800.

Table 5-2 summarizes the total costs of the KRONOS system.

TABLE 5-2

COSTS ASSOCIATED WITH KRONOS--TIMEKEEPER 55

COSTS / YEARS	1	2	3	4	5	6	7	8
Hardware	$9200	0	0	0	0	0	0	0
Software	$4000	0	0	0	0	0	0	0
Maintenance								
S-ware	$300*							
H-ware	$250*							
Personnel	$4420*							
Badges/Forms	$20,800	0	0	0	0	0	0	0
Terminals	$279,400	0	0	0	0	0	0	0
Processors	$21,000	0	0	0	0	0	0	0
Maintenance	$31,750*							
Total	$371,120	$36,720*						

*Same annual costs assumed for each year

b. COMPUSCAN--OBM Laser

The costs associated with the COMPUSCAN system used in the Alameda County location were as follows:

Hardware:	$102,500
Maintenance ($800/mo X 12 mos)	$9,600/yr

Personnel:	(200 people X [.2 mo X $1250/mo] X 12 mo) + ([10,000 forms/2000 forms/hr] X $6/hr X 26 pay pds.). This cost reflects both time recording and Data Processing resources	$600,780
Badges/Forms:	($70/thsnd X 20 thsnd/mo X 12 mos)	$16,800

In order to accommodate the requirements of paying only 6400 employees, the following avoidable costs were deducted from the costs associated with the processing of 10,000 employees.

(1) Personnel: $216,280

This amount was determined by estimating the number of employees serviced by the 200 time-keepers at Alameda County (10,000/200 = 50). The application at the Supply Center will service 6400. If we divide 6400 by 50, we can estimate that 128 time-keepers will be required. This amount is entered into the original equation for the cost of personnel as follows: (128 people X [.2 mo X $1250/mo] X 12 mos). The time-keeper total costs of $384,000 must then be added to the Data Processing personnel costs. These will be computed in the same manner as before but the number of forms will be changed to reflect the 6400 employees as well. The calculation will be as follows: ([6400 forms/2,000 forms/hr] X $6/hr X 26 pay pds.) = $500. A grand total net change in the cost of personnel will be the difference between $600,720 and the adjusted total of $384,500 which equals $216,280.

(2) Badges: $6,048

This amount reflects the reduction in costs for servicing of 6400 employees. The calculation follows the one used previously to determine the costs of badges/forms. The value of 12.8 which reflects the approximate amount of forms required to service 6400 employees replaces the 20 as follows: ($70/thsnd X 12.8 thsnd/mo. X 12 mos) = $10,752. The difference between this value and the original value of $16,800 is $6,048.

Table 5-3 reflects the net costs of the OBM laser equipment as it would be implemented into our Supply Center environment. It is currently possible to obtain lower costs for certain hardware items. Unfortunately, the lower costs would not be available until actual negotiations take place. Therefore, the costs used will reflect the historical transaction prices.

TABLE 5-3

COSTS ASSOCIATED WITH COMPUSCAN--OBM LASER

COSTS / YEARS	1	2	3	4	5	6	7	8
Hardware	$102,500	0	0	0	0	0	0	0
Maintenance:								
Hardware	$9600*							
Personnel	$384,500*							
Badges/Forms	$10,752*							
Total	$507,352	404,852*						

*Same annual costs assumed for each year

c. NATIONAL CASH REGISTER--Westinghouse

The costs associated with the National Cash Register system in the Westinghous location were as follows:

Hardware:	$528,295	
Maintenance:	$63,576/yr	
Personnel:	$30,000/yr	($600/wk X 50 wks/yr)
Badges:	$.75 each	
Wooden Benches:	$40,800	(51 terminals X $800 each)

In order to expand this system to reflect an estimated cost for the system needed to handle the Supply Center workload, the following adjustments were also made: 77 additional terminals. Based on the previous assumption of 50 employees per terminal, a total of 126 terminals are required. Each terminal is multiplied by the unit cost of $5800 and the $800 required to build the wooden bench to house the unit. The total additional cost of terminals is therefore $508,200.

Table 5-4 reflects the summary of costs associated with the NCR-Westinghouse system.

TABLE 5-4

COSTS ASSOCIATED WITH NATIONAL CASH REGISTER--WESTINGHOUSE

COSTS / YEARS	1	2	3	4	5	6	7	8
Hardware	$528,295	0	0	0	0	0	0	0
Maintenance:								
Hardware	$63,576*							
Personnel	$30,000*							
Badges/Forms	$4800	0	0	0	0	0	0	0
Benches	$40,800	0	0	0	0	0	0	0
Terminals	$508,200	0	0	0	0	0	0	0
Totals	$1,175,671	$93,576*						

*Same annual costs assumed for each year

d. NATIONAL CASH REGISTER--NUWES

The costs associated with the National Cash Register system in the NUWES location were as follows:

Hardware:	2 CPU's @ $48,500	= $97,000
	15 Printers @ $1800	= $27,000
	3 Tape Drives @ $14,000	= $42,000
	Disc Processor @ $42,000	= $42,000
	Disc Controller @ $9,000	= $9,000
	89 Transactors @ $5,800	= $516,200
	21 Terminals @ $1400	= $29,400
	Disc Memory @ $45,000	= $45,000
Total:		$807,600

Maintenance:	$23,500/yr
Personnel: ($5100/mo X 12 mos)	$61,200/yr
Badges/Forms: (6400 X $.25 ea)	$1600
Wooden Benches: (89 benches X $500)	$44,500

In order to accommodate the requirements of the analysis environment, there is an additional requirement of 39 terminals. This number was computed using the assumption of 50 employees per terminal for a total of 128 terminals. The additional 39 terminals will cost $5800 each and will require a bench at $500 each as well for a total of $245,700. Table 5-5 summarizes the cash flow associated with NCR-NUWES over the 8 year period.

TABLE 5-5

COSTS ASSOCIATED WITH NATIONAL CASH REGISTER--NUWES

COSTS \ YEARS	1	2	3	4	5	6	7	8
Hardware	$807,600	0	0	0	0	0	0	0
Maintenance	$23,500*							
Personnel	$61,200*							
Badges/Forms	$1600	0	0	0	0	0	0	0
Benches	$44,500	0	0	0	0	0	0	0
Terminals	$245,700	0	0	0	0	0	0	0
Total	$1,184,100	$84,700*						

*Same annual costs assumed for each year.

e. TANDEM System--NARF Alameda

The costs associated with the TANDEM system in the NARF location are as follows:

Hardware:	4 CPU's @ $123,400	=	$493,600
	Associated peripherals	=	$500,000
	2 Punch machines @ $2,000	=	$4,000
	Hollerith punch @ $8,500	=	$8,500
	175 Tandem terminals @ $6,300	=	$1,102,500
Total:			$2,108,600
Maintenance:			
	Hardware		$160,000/yr
	Software		$300,000/yr
Badges:	([6400 badges X $.23 ea] + [1000 job cards X $.35 ea])		$1,822

In order to evaluate this system on a comparable basis, we must reduce the number of terminals in use to the 128 total previously computed. This would mean a reduction in costs of 47 terminals at $6,300 each for a total of $296,100. Table 5-6 summarizes the cash flow associated with the TANDEM system over the 8 year period.

TABLE 5-6

COSTS ASSOCIATED WITH TANDEM SYSTEM--NARF

COSTS \ YEARS	1	2	3	4	5	6	7	8
Hardware	$1,812,500	0	0	0	0	0	0	0
Maintenance:								
Software	$160,000*							
Hardware	$300,000*							
Badges/Forms	$182	0	0	0	0	0	0	0
Totals	$2,272,500	$460,000*						

*Same annual costs assumed each year.

f. Summary of System Cash Flows

Table 5-7 summarizes the information presented in the preceeding paragraphs for all of the alternatives.

TABLE 5-7

CASH OUTFLOW SUMMARY

SYSTEM \ YEARS	1	2	3	4	5	6	7	8
Present	$202,145*							
KRONOS	$371,120	$36,720*						
COMPUS	$507,352	$404,852*						
NCR-1	$1,175,671	$93,576*						
NCR-2	$1,184,100	$84,700*						
TANDM	$2,272,500	$460,000*						

*Same annual costs assumed each year.

C. ANALYSIS OF POTENTIAL SYSTEM BENEFITS

In addition to the discussion of the cash outflows of the various alternatives it is important to evaluate the benefits of the various alternatives. Table 5-8 indicates the major benefits identified in the research and whether each of the alternative systems is also capable of offering the benefit or its equivalent.

TABLE 5-8

SYSTEM BENEFIT SUMMARY

BENEFITS \ SYSTEMS	Present	KRONOS	COMPUS	NCR-1	NCR-2	TAND
NON-QUANTIFIABLE BENEFITS						
Eliminates manual card preparation		X		X	X	X
Eliminates manual audit of cards		X		X	X	X
Eliminates reconciliation of pay and labor hours		X	X	X	X	X
Real-time update		X		X	X	X
Real-time inquiry		X		X	X	X
Allows real-time management control		X		X	X	X
Allows easy future expansion		X	X	X	X	X
QUANTIFIABLE BENEFITS--Potential Savings						
improved accuracy		$400,000	$400,000	$400,000	$400,000	$400,000
time control		$800,000		$800,000	$800,000	$800,000

The ranking shown in Table 5-7 should not be significantly modified by the benefits presented as most of the systems offer the same benefits. However, one of the automated systems proves to have fewer capabilities than the others. The COMPUSCAN system still relies heavily on the manual input of information. The costs are therefore higher and the lower accuracy proves to be a handicap as well. The objective of the accumulation of the labor data was to allow management to use the information to provide a better means of increasing personnel productivity. Also, the COMPUSCAN system does not have the real-time access to information that is available from other automated systems and therefore lacks one of the major benefits of an automated system.

There are additional significant poins which should be discussed prior to a final ranking.

In Chapter IV, losses due to calculation errors and lost time due to employee misrepresentation on manually prepared time cards were discussed. If these potential savings were included, annual positive cash flows would be reflected for all of the automated alternatives as follows: Reduction in calculation errors: based on a $6.00 average hourly rate, we would enter the graph reflected in Appendix E and multiply the value associated with the costs for 100 employees by 64 to reflect our proposed environment. This value is equal to $400,000.

All of the automated alternatives with the exception of the COMPUSCAN system would also gain the added benefits of

a reduction in the lost time of employees. The COMPUSCAN system relies on the manual input of employees onto a document and does not therefore eliminate the possibility of employee errors. Based on a $6.00 average hourly rate, we would enter the graph reflected in Appendix D and multiply the value associated with the costs for 100 employees by 64 again. This value is equal to $800,000.

The current system has additional problems that will result in additional negative cash flows in the future. Currently, Navy data processing activities are experiencing increasing reliability and maintainability problems with the installed Punch Card Accounting Machines. There are a number of contributory causes to this problem: (1) age of the equipment, (2) decrease in the number of maintenance personnel with this type of equipment repair experience, and (3) a growing shortage of repair parts. The number of dollars required to rectify this problem will become tremendous, if the present method of operation is maintained.

In order to reflect the various alternatives completely, Table 5-9 summarizes the net costs for each system after potential savings have been deducted.

TABLE 5-9

SUMMARY OF SYSTEM NET CASH FLOWS

SYSTEM \ YEARS	1	2	3	4	5	6	7	8
Present	-$202,145*							
KRONOS	$828,880	$1,163,280*						
COMPUS	-$107,352	-$4,852*						
NCR-1	$24,329	$1,106,424*						
NCR-2	$15,900	$1,115,300*						
TANDM	-$1,072,500	$740,000*						

*Same annual costs assumed each year.

Table 5-10 presents a summary of the net present value calculations for each of the systems over the 8 year period.

TABLE 5-10

ADJUSTED CASH FLOW SUMMARY

SYSTEM:	Net Present Value
Present	-$1,186,272
Kronos	+$6,492,214
Compus	-$130,974
NCR-1	+$5,410,864
NCR-2	+$5,445,648
TAND	±$2,530,130

VI. SUMMARY AND CONCLUSION

A. SUMMARY

In today's business environment, management is faced with finding better ways to increase the productivity of their personnel. Automated data processing has allowed many functions within the office environment to be done more cost-effectively, thus improving personnel productivity. This study examines the labor-intensive methods that the Navy uses to accumulate attendance and labor data at the Naval Supply Center in Oakland, California and potential alternatives of automated systems.

An economic analysis was done to determine if the automation of this function should be considered. Under the guidance of the DOD Instruction on economic analysis, the cash flows and benefits of the present system and five automated systems were compared. The comparative analysis uses a judgmental approach to determining which of the systems is most cost effective given that they each can perform the data collection function at the Supply Center.

The identification of cash flows for each system was complex. One of the primary areas of difficulty was system hardware. In many cases, exact historical costs were not available. In other sites, the hardware costs were determined based on a negotiated price. The negotiation process is common when large automated systems are installed due to quantity discounts,

etc. System hardware representatives were reluctant to provide specific cost data as a result. Another consideration in the identification of costs for hardware is the rapid pace of technology in this field. The general trend of prices is to decrease in the future because of innovations which make it less expensive to perform the same function.

Additional complications in cash flow analysis arose when the estimated cost of an alternate system had to be adjusted either because of the expansion or contraction needed to meet the requirements of servicing the 6400 employees of the Supply Center. A system hardware representative would be required to do a detailed study of the Supply Center in order to determine a more accurate estimate of personnel and maintenance costs. Therefore, various assumptions were required to estimate these costs.

Benefit analysis was more direct but, less quantitative. In general, the automated systems offered similar benefits. However, the COMPUSCAN system fell short in those areas where manual input would otherwise be eliminated and in real-time access. This system still relies on the manual generation of the original input documents and does not provide inquiry terminals in the work areas for management personnel. On the otherhand, NCR and TANDEM systems provide large amounts of existing storage capacity to handle other functions in addition to the attendance and labor data collection.

The choice of automated alternatives was also a complicated matter. The criteria for selection rested primarily on the

need to find a system that could handle the size and diversity of the Supply Center. The field of source data automation is relatively young. The choice of available sites was limited by this factor.

B. CONCLUSION

The decision to consider automation at the Naval Supply Center is justified by this economic analysis. The evidence clearly indicates that there are more efficient means of collecting attendance and labor data than the present manual system. The KRONOS system appears to address the collection of attendance and labor data in the most efficient and cost effective manner. The net present value of the adjusted cash flows in the comparative analysis indicates that the KRONOS system, with a net present value of +$6,492,214, ranks number one. The NCR systems at Westinghous and NUWES follow closely with net present values of +$5,410,864 and +$5,445,648 respectively.

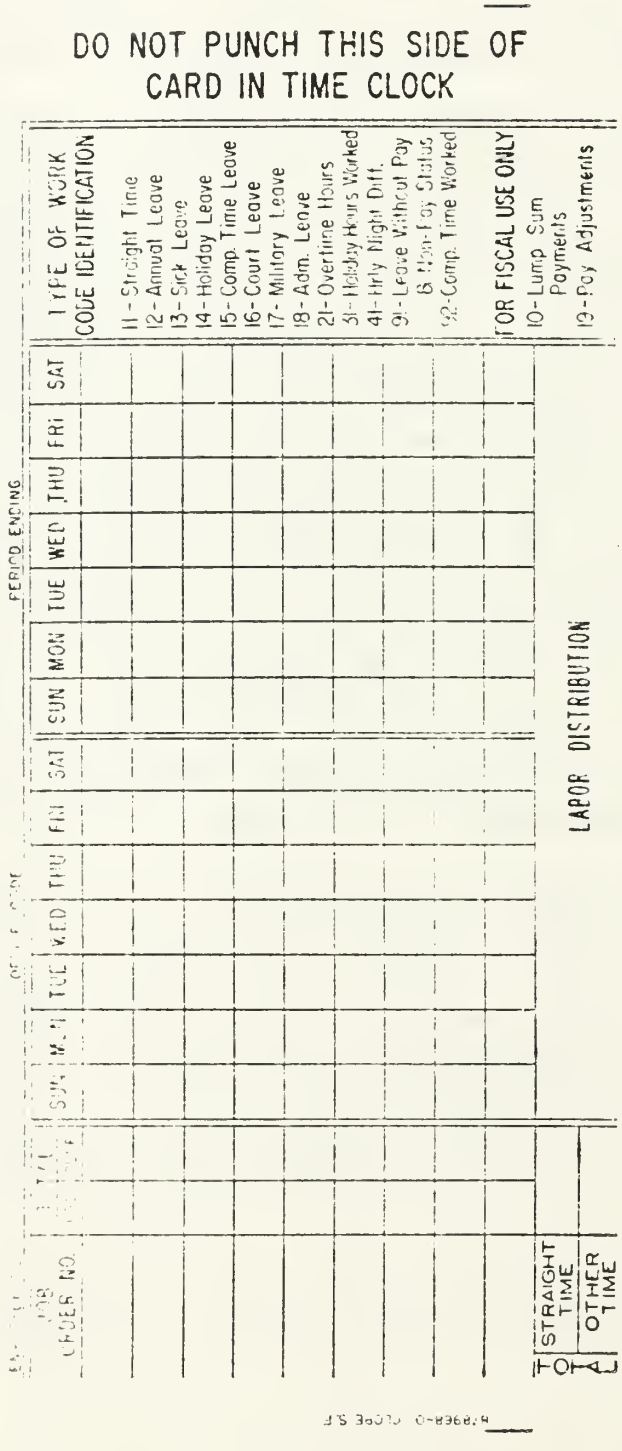
The selection of the KRONOS system is also recommended based on the singularity of its mission. A simple, standardized system appears to have the greatest chance of acceptance in an environment that may be initially hostile to its implementation. In all of the automated sites, the transition was done slowly and carefully to avoid protracted problems in payroll processing and a general loss of goodwill toward the system.

The conclusion derived from this study was based on several cost estimating assumptions and limitations on the scope of analysis. Prior to the selection of an automated system, the decision maker should validate the cost estimating assumptions with prospective suppliers. In addition, it may be desirable to conduct further investigation into other possible alternatives to broaden the field of potential candidates of automated systems. If the decision maker desires a system to address only the payroll processing capability, potential system candidates should be evaluated closely. The additional storage capacity, like that found in the NCR system, would appear to be an unnecessary expense in that event.

The subsequent selection of an automated system will depend on the decision maker who must also evaluate other important factors such as: (1) the potential user acceptability, (2) the availability of funds, (3) the alternative use of these funds and (4) the position of top management toward automation. These factors were not considered in this comparative analysis. Regardless of which system is selected, it is clear that consideration of this matter is in the best interests of better productivity and consequently those of the Navy, especially in view of the decreasing hardware cost discussed earlier.

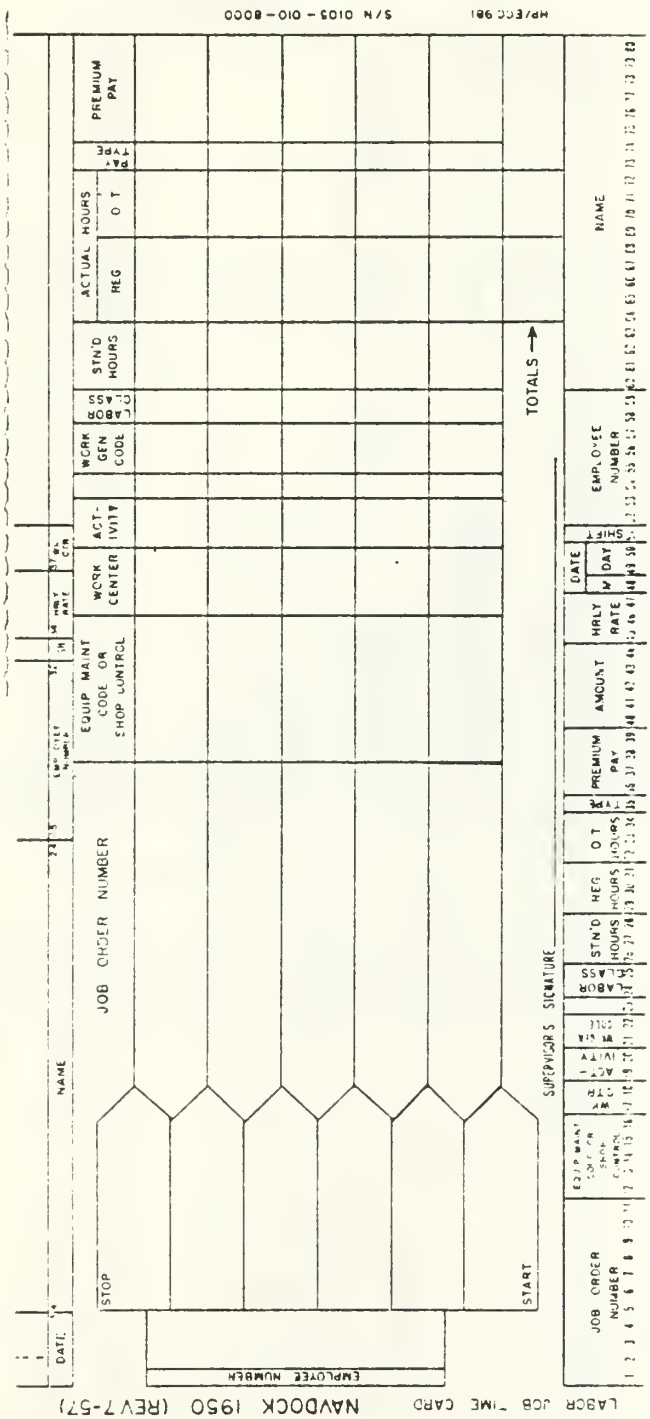
APPENDIX A

MANUAL TIME CARD



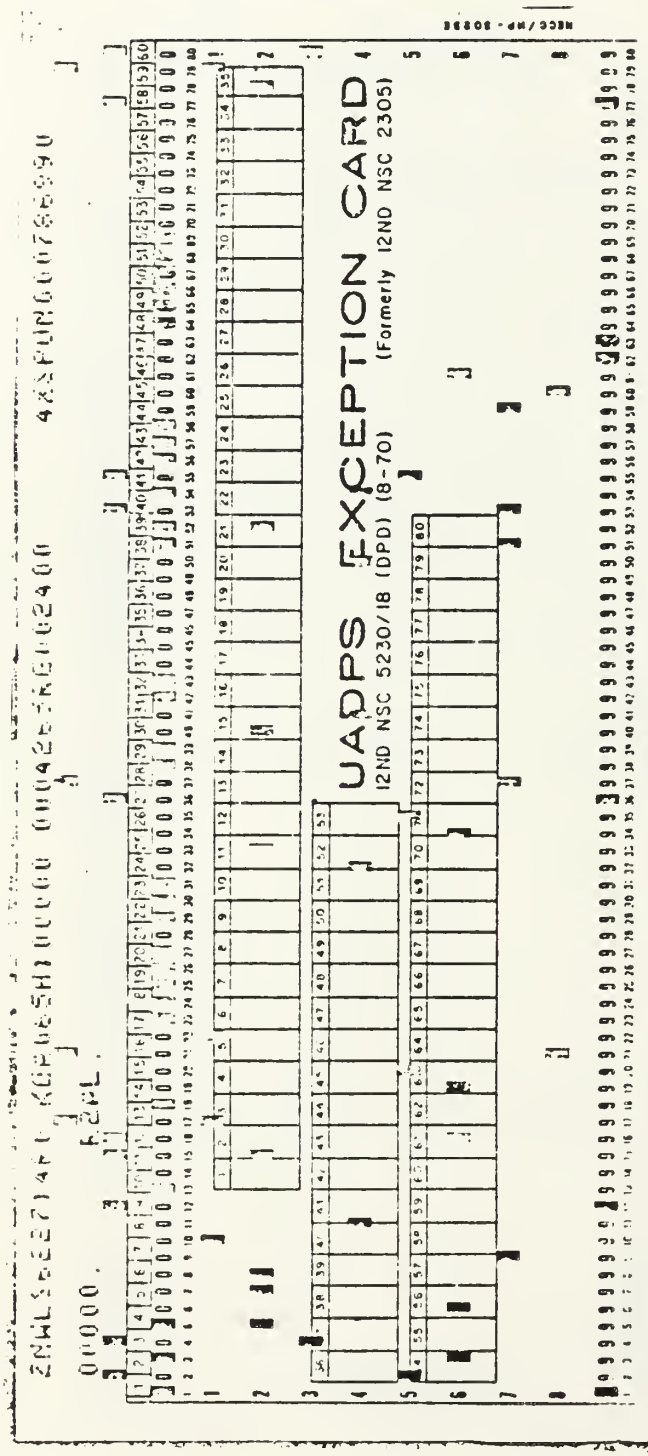
APPENDIX B

MANUAL LABOR CARD



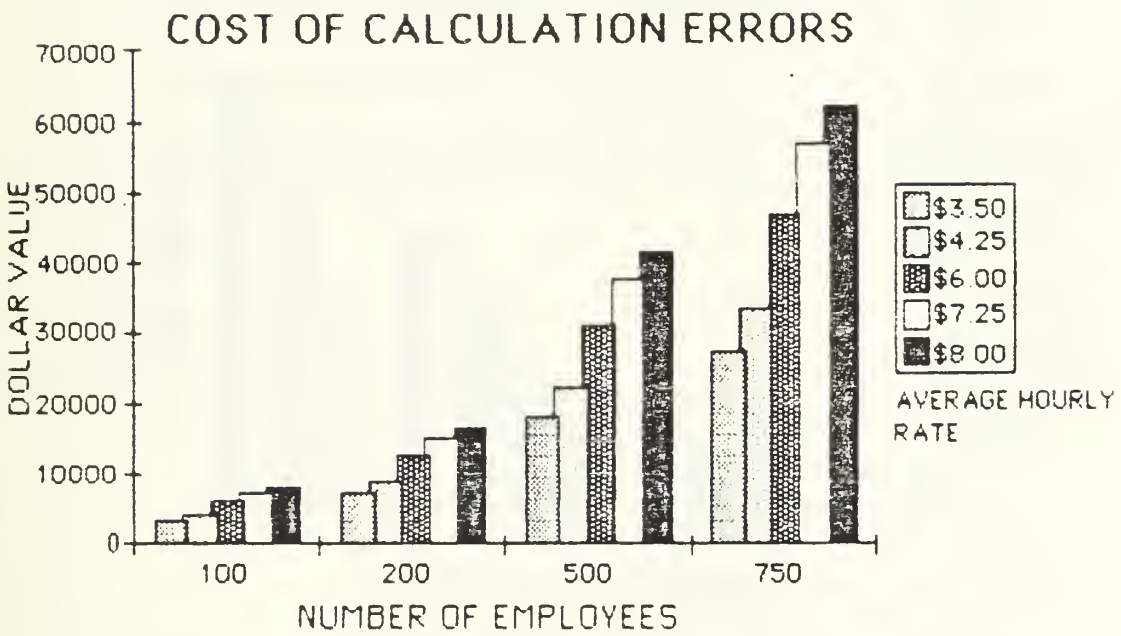
APPENDIX C

EXCEPTION CARD



APPENDIX D

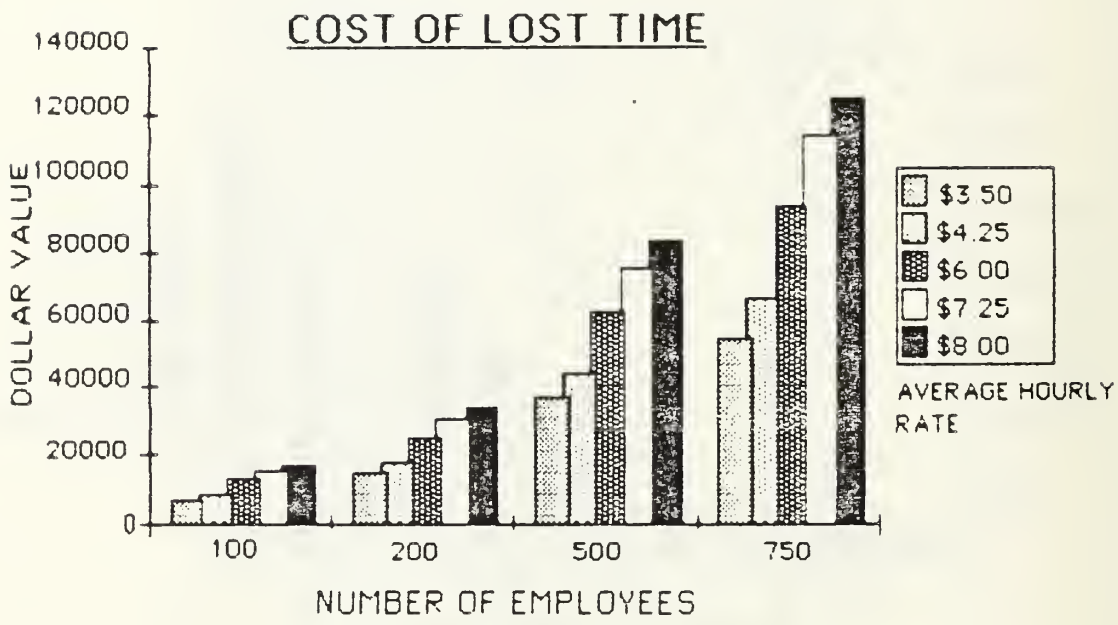
COST OF CALCULATION ERRORS



THIS CHART INDICATES THE COST IMPACT OF A ONE-HALF PERCENT ERROR RATE ANNUALLY IN OVERPAYMENTS TO EMPLOYEES (AMERICAN PAYROLL BUREAU)

APPENDIX E

COST OF LOST TIME



THIS CHART INDICATES THE COST IMPACT OF ONLY FIVE MINUTES OF LOST TIME PER EMPLOYEE PER DAY (AMERICAN PAYROLL BUREAU)

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Thesis
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system versus automa-
ted alternatives.